

The Journal of the American Association of Zoo Keepers, Inc.

Animal Keepers' Forum



April 2021, Volume 48, No.4

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The American Association of Zoo Keepers, Inc. exists to advance excellence in the animal keeping profession, foster effective communication beneficial to animal care, support deserving conservation projects, and promote the preservation of our natural resources and animal life.

ABOUT THE COVER

This month's cover photo comes to us from Ashley Arimborgo of Cheyenne Mountain Zoo. "Petrie" is an 18-year-old Abyssinian Ground Hornbill (*Bucorvus abyssinicus*) at Cheyenne Mountain Zoo. As one of the members of our free-flight bird show, he never failed to wow guests. With the changes that were necessary in 2020 and the COVID-19-related restrictions, he may not get to fly quite so stupendously as before, but he continues to wow and amaze guests of all ages regardless.

Abyssinian Ground Hornbills are the second-largest hornbill species, only slightly behind the Southern Ground Hornbills. Like many hornbills, Petrie shares his food and beak slaps to demonstrate his interest in the people that he interacts with. In the wild, this behavior would occur with a mate, and as a naturally inquisitive animal in human care, he appears to enjoy those same social behaviors with his environment regardless of bird or human species!

Articles sent to *Animal Keepers' Forum* will be reviewed by the editorial staff for publication. Articles of a research or technical nature will be submitted to one or more of the zoo professionals who serve as referees for AKF. No commitment is made to the author, but an effort will be made to publish articles as soon as possible. Lengthy articles may be separated into monthly installments at the discretion of the Editor. The Editor reserves the right to edit material without consultation unless approval is requested in writing by the author. Materials submitted will not be returned unless accompanied by a stamped, self-addressed, appropriately-sized envelope. Telephone, fax or e-mail contributions of late-breaking news or last-minute insertions are accepted as space allows. Phone (330) 483-1104; FAX (330) 483-1444; e-mail is shane.good@aazk.org. If you have questions about submission guidelines, please contact the Editor. Submission guidelines are also found at: aazk.org/akf-submission-guidelines/.

Deadline for each regular issue is the 3rd of the preceding month. Dedicated issues may have separate deadline dates and will be noted by the Editor.

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ANIMAL KEEPERS' FORUM

TO CONTACT THE AKF EDITOR:

Shane Good, AKF Editor

P.O. Box 535, Valley City, OH 44280

330-483-1104

Shane.Good@aazk.org

AAZK Administrative Office

American Association of Zoo Keepers

8476 E. Speedway Blvd. Suite 204

Tucson, AZ 85710-1728

520-298-9688 (Phone/Fax)

CHIEF EXECUTIVE/FINANCIAL OFFICER:

Ed Hansen | Ed.Hansen@aazk.org

DIRECTOR of PROFESSIONAL DEVELOPMENT and CONFERENCE MANAGEMENT

Bethany Bingham, Bethany.Bingham@aazk.org

ANIMAL KEEPERS' FORUM - EDITOR

Shane Good, Shane.Good@aazk.org

GRAPHIC DESIGNER

Elizabeth Thibodeaux, Elizabeth.Thibodeaux@aazk.org

ENRICHMENT OPTIONS COLUMN COORDINATORS

Stephanie Miner

Beth Stark-Posta, Beth Ament-Briggs

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AAZK C.O.R.E. allows the creation of dynamic and interactive learning courses on these same topics in a way that will hopefully grant a greater level of comprehension for those who want to learn how to more effectively lead.

Spring marks the one-year anniversary of the COVID-19 pandemic's presence and impact on our daily lives. But as vaccine distribution begins throughout the country and the world, many can finally see a light at the end of the tunnel. As facilities, AAZK Chapters, and members start to ramp up more normal operations, AAZK is prepared to offer support for the process of reviving activities and participation.

The first quarter of the year sees new Chapter leaders elected and this can be difficult at the best of times. The AAZK Resource Committee has launched resources that Chapter leaders can employ to help them learn the ropes and most effectively steer their Chapters. Monthly Chapter forums have begun and will continue with topics such as responsibilities, finances, and fundraising among others. These forums connect established leaders with those seeking guidance and allows communication between Chapters. These forums can establish a network of support for our Chapters to rely on.

In addition to connectivity, understanding is an important aspect of Chapter operations for new leaders. The AAZK Resource Committee has had static documents related to Chapter operations for some time, but the advent of AAZK C.O.R.E. allows the creation of dynamic and interactive learning courses on these same topics in a way that will hopefully grant a greater level of comprehension for those who want to learn how to more effectively lead. Current Chapter leadership courses include a Chapter Recharter guide and a series on Chapter Operations with future plans for topical courses on topics such as fundraising and BFR guidelines.

Reopenings around the world make supporting conservation organizations and fundraising success even more important. In addition to the forums and AAZK C.O.R.E. lessons, the Bowling for Rhinos and Trees for You and Me Program teams are prepared to provide support for Chapter events. The BFR team constantly evolves the BFR Resource Drive and seeks to establish stronger connections between the BFR partners and the AAZK Chapters that support them through BFR events. Trees for You and Me continues to grow with the creation of a TFYM Resource Drive. Perhaps the most exciting development for Trees for You and Me is the new trip raffle. Chapters that donate funds to TFYM will receive entry into a raffle with one lucky AAZK member winning a spot in Polar Bears International's Climate Alliance Program in Manitoba.

Reengaging AAZK members and Chapters will be a difficult challenge after a year of disruption, but AAZK is prepared to provide support in any way necessary. In addition to making use of the resources listed above, please contact the AAZK offices, Board of Directors, or Committees and Programs for any assistance. We are here to help you succeed and will be happy to assist you in any way we can as we seek to support AAZK and its members in their personal and professional missions.

Cheers,

Paul

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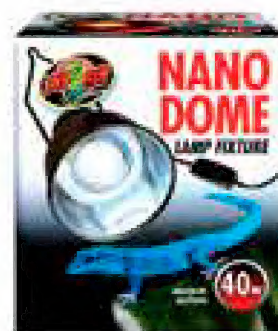
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CONFERENCE UPDATE

AAZK National Conference

Los Angeles, CA

August 29 - August 31, 2021

While the worldwide COVID-19 pandemic continues, AAZK is attempting to finalize the model of learning that will be the AAZK Conference in 2021. At this moment in time, restrictions on public assembly in the state of California would cause the cancellation of the 2021 event. For this reason AAZK is planning for a virtual event, with hopes that with vaccination rollout, and relaxation of public gatherings forecast in the future, may present the opportunity for AAZK to actually offer a hybrid learning event - a combination of in-person meetings and presentations with distance learning via a digital educational platform.

With the scheduled conference being several months in the future, AAZK is balancing what is known against the unknown and planning for both, with the strong desire to present an educational forum for our membership in uncertain times and to bring back a sense of professional normalcy. At a point in the very near future a final decision must be made so that all efforts can be shifted to producing a successful and educational program for the membership.

FINAL CALL

for Paper & Poster Abstracts

for the 2021 AAZK National Conference

CALL FOR PAPERS AND POSTERS

The AAZK Professional Development Team is pleased to announce the Call for Papers and Posters for the 2021 AAZK National Conference hosted by the Los Angeles AAZK Chapter. The deadline for submission of abstracts for Papers and Posters is May 1, 2021. Authors will be notified regarding acceptance by June 1, 2021.

HOW TO SUBMIT YOUR ABSTRACT FOR CONSIDERATION:

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PAPERS

Authors will be allowed 15 minutes for a presentation with five minutes of Q & A immediately following. If accepted, you may be scheduled to present your paper in the main ballroom, or you may be scheduled to present your paper during a concurrent, themed paper session which may have a more intimate setting.

POSTERS

Posters will be on display throughout the Conference with a dedicated Author Session scheduled for the evening of August 31st. Prior to the Author Session, posters will be judged by members of the AAZK Professional Development Team on criteria such as adherence to the conference theme, innovation, and poster layout and organization. Certificates will be awarded to the top three highest scoring posters during the Conference Awards Ceremony immediately following the Poster Author Session.



QUESTIONS?

Any questions should be directed to PDC@aazk.org with ATTN: Paper or Poster as part of the e-mail subject.

Effect of Music Enrichment on Three Species of Birds in a Free-flight Aviary

Benyapa Khowpinitchai, Serena G. Pritchard, Millar H. Minahan, and Susan E. Lewis
Department of Life Sciences, Carroll University,
100 North East Avenue, Waukesha, WI 53186

Abstract

Enrichment has been shown to reduce stereotypic behavior in a variety of zoo animals. Birds in zoos often receive less attention compared to mammals with respect to behavioral enrichment. Because birds have an acute sense of hearing, auditory enrichment has potential to be a cost-effective means of enhancing the welfare of zoo birds. We investigated how two genres of music (classical music and smooth jazz) affected three bird species: Inca terns

(*Larosterna inca*), white-bellied storks (*Cochlearius cochlearius*), and superb starlings (*Lamprotornis superbus*). We also collected feedback regarding the experience of visitors in the exhibit during the study treatments. The visitors tended to rate jazz the highest. We found species-specific differences in response to music. However, more research is needed to verify if music is beneficial as a form of auditory enrichment in zoo aviaries.

Introduction

The fundamental goal of behavioral enrichment programs has been to improve the quality of life for zoo animals. In zoos, a variety of enrichment strategies targeting sensory cues and artificial manipulation of habitats have been documented to reduce stereotypic behaviors in several zoo mammals (e.g. Bayne, 1991; Bloomsmit et al., 1988; Celli et al., 2003; Manser, 1996; Nicol, 1995). Zoo avian species generally



receive less attention than mammals regarding behavioral enrichment. However, behavioral issues, such as stereotypies and conspecific attacks have been observed in common bird species (reviewed by McKinney & Bunney, 1979). For example, avian species used for behavioral research were described to exhibit a range of behavioral abnormalities (Garner et al., 2003) such as feather plucking. Plucking has been reported in approximately 10% of zoo birds, including hand-reared pets (Grindlinger, 1991). Research has shown that zoo birds would benefit physically and psychologically from behavioral enrichment. For example, a study on orange-winged Amazon parrots (*Amazona amazonica*) demonstrated that enriched birds showed significantly less stereotypy compared to unenriched birds. (Meehan, Garner, and Mench, 2004).

Auditory enrichment could potentially be an easy and inexpensive means of enhancing animal welfare in zoo settings. Robbins and Margulis (2014) demonstrated a significant decrease in abnormal behaviors of western lowland gorillas (*Gorilla gorilla*) during a naturalistic sound simulation of a rainforest. In addition to natural sounds, anthropogenic sounds, such as music, have also been used for enrichment (reviewed by Wells 2009). For example, Asian elephants (*Elephas maximus*) spent less time engaging in stereotypic behavior when classical music was played (Wells & Irwin, 2008).

Enrichment associated with the use of auditory stimuli could be a logical tool to incorporate into enrichment programs for captive birds (Scanes, 2015). Previous research regarding auditory enrichment on various bird species demonstrated an increase in locomotion during natural sounds, rock music, and classical music (Robbins & Margulis, 2016). In addition, the same study reported that only two of the three species of interest (superb starlings and mousebirds) exhibited a higher frequency of vocalization in response to all stimuli, whereas Lady Ross’s turacos only vocalized more when rock music was played. The influence of music appears to vary across conditions and species (Robbins & Margulis, 2016;

Behavior	Description	Type of Behavior
Fly	Individual has feet off the ground with wings extended and moves through the air from one location to another. This category is exclusive to flying only.	Active
Walk/Hop	Individual uses its feet to propel itself laterally on the ground to move a distance	
Preen	Individual uses its beak to arrange feathers	
Vocalize	Individual projects noise from its mouth	
Other	Behavior not listed above	
Stationary	Individual stays in one position without moving its body parts; however, this behavior includes any slight head and feet movements	Inactive
Out of Sight	Individual cannot be seen by observer	n/a

Table 1. Ethogram describing behaviors of bird species

additional examples reviewed by Wells, 2009). More research is necessary to fully understand how music affects zoo birds.

We investigated the effects of two genres of auditory stimuli, classical music and smooth jazz, on the behaviors of Inca terns (*Larosterna inca*), white-bellied storks (*Cochlearius cochlearius*), and superb starlings (*Lamprotornis superbus*). We hypothesized that both music types would lead to changes in behaviors of the bird species. Based on previous music enrichment research on birds (Robbins & Margulis, 2016), we predicted that they would exhibit more active behaviors, including flying

and vocalizing. In addition to assessing the birds’ response to music, we also evaluated how music affected zoo visitors’ experience within the exhibit. Robbins and Margulis (2016) noted that music may potentially improve the experience of zoo visitors. Hence, we predicted that music would lead to more positive feedback from the guests on their overall experience.

Materials and Methods

Study Site and Subjects

The study subjects were zoo-raised Inca terns (*Larosterna inca*; N = 20), white-bellied storks (*Ciconia abdimii*; N = 9), and superb starlings (*Lamprotornis superbus*; N = 7) housed



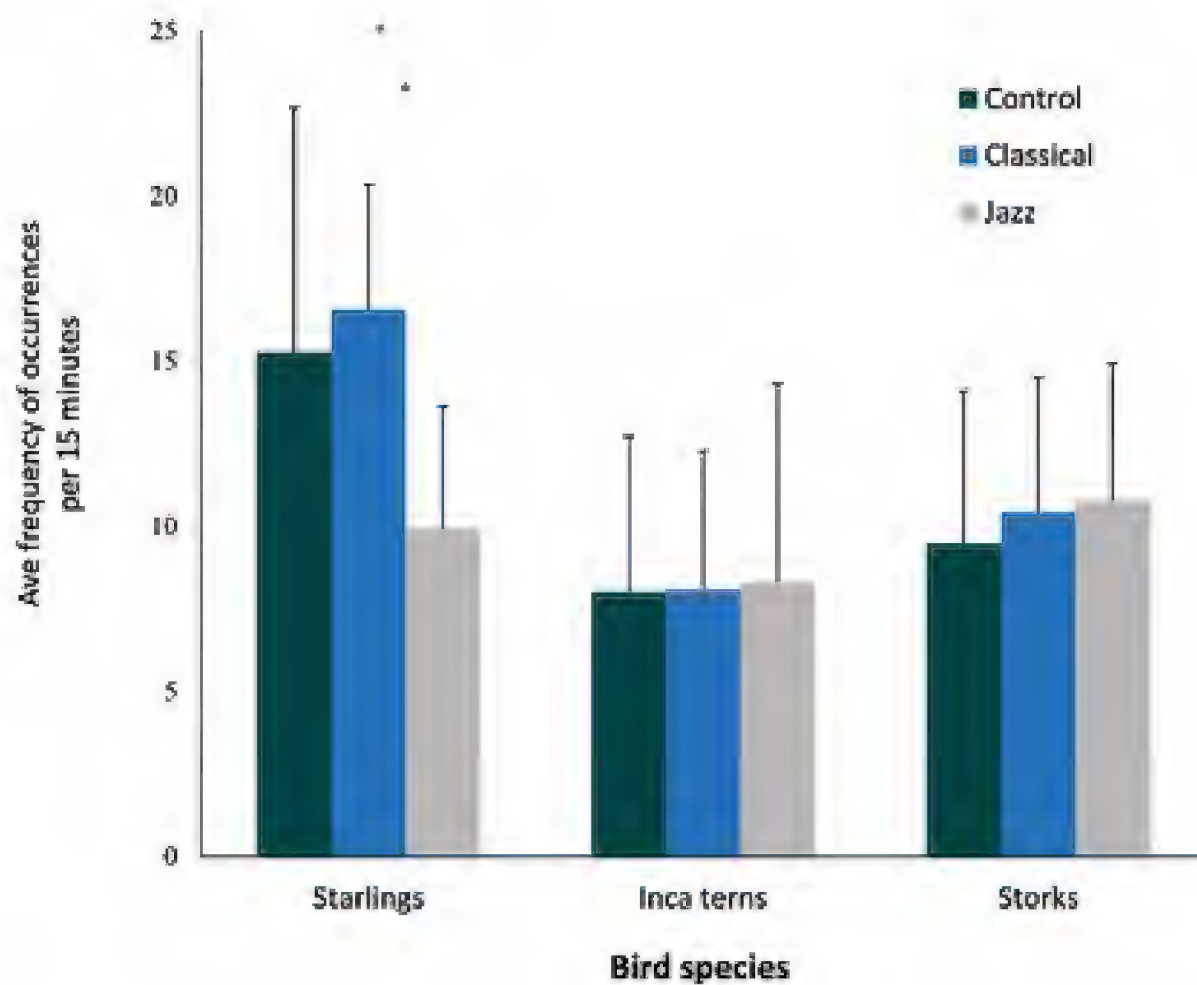


Figure 1. Average frequency of inactive behaviors ($\pm 1SD$) in the three bird species during the three study treatments.

at the Milwaukee County Zoo in the East Flight exhibit. Birds could be identified by colored bands around the legs. The exhibit was a free-flight area that housed over 88 individuals of 17 bird species.

Procedure

We used *ad libitum* sampling to identify behaviors of bird species and generate an ethogram (Table 1). Observational data were recorded in 15-minute intervals, over the span of 2.5 hours per

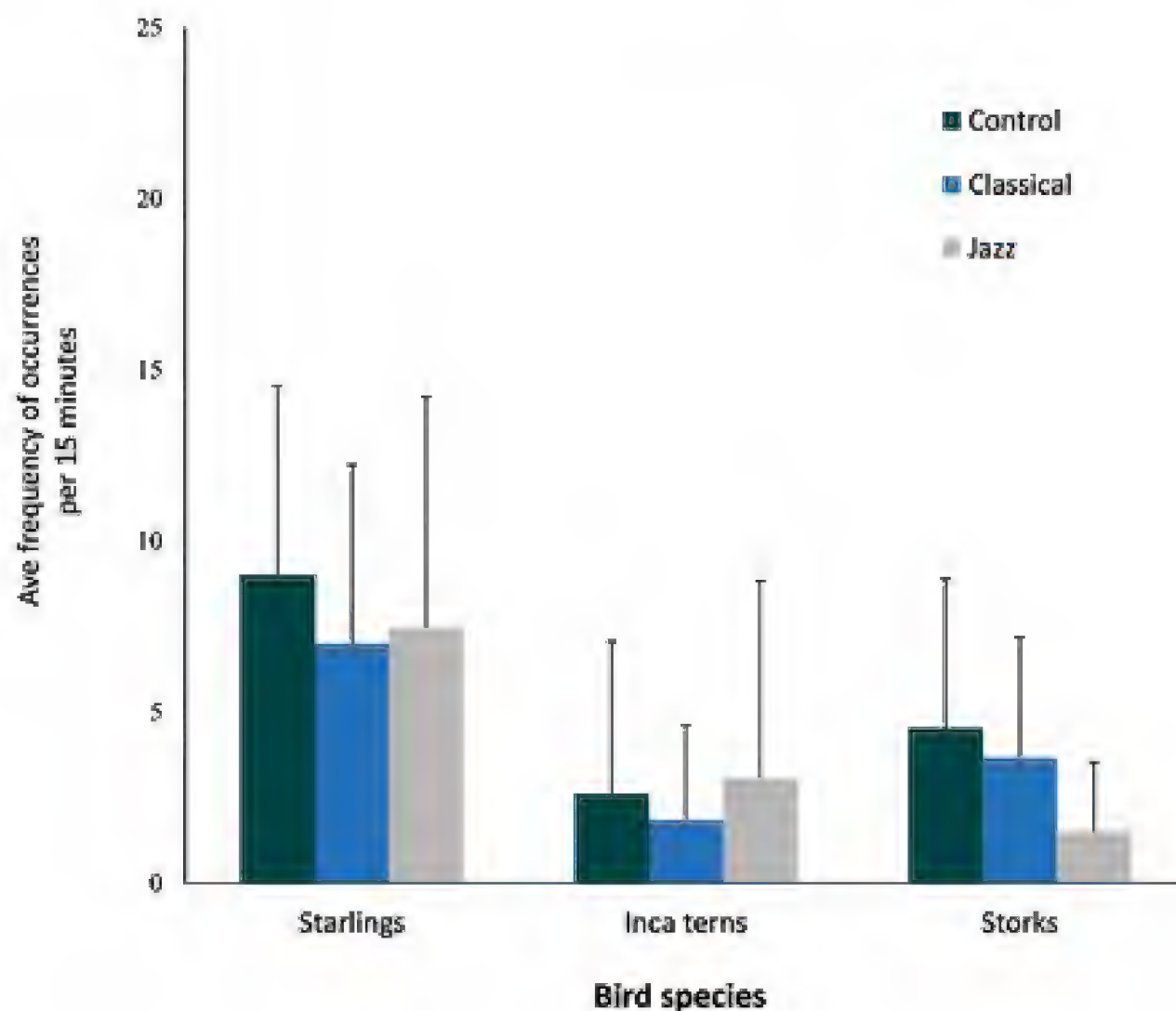


Figure 2. Average frequency of occurrences of walking/hopping ($\pm 1SD$) in the three bird species during the three study treatments.

day. Data collection spanned six weeks for a total of approximately 15 hours (45 person-hours) of observation. We recorded the number of occurrences of each behavior using focal animal sampling with continuous recording (Rose, 2000). Separate behaviors were defined using a three-second rule. For every data recording interval, we randomly selected a study subject and identified them by their identification tag. If the bird we were observing left our sight, we marked “out of sight.” To maintain consistency in data collection among the observers, we conducted an inter-observer reliability test three times over the course of the study and ensured 85% similarity in collected data during each test.

Recordings of a single composer’s classical music (Johann Sebastian Bach) and one duet’s smooth jazz (Bob James and Earl Klugh) were selected to reduce music variability. These genres were selected because they did not have strong percussion or loud bass that might startle the birds. Only one genre of music was played per day of observation (or no music on control days). Music was played continuously through the behavioral recording intervals and during breaks on a portable speaker, placed approximately one meter off the ground.

To assess the effects of music on the overall experience in the exhibit, unsystematically-selected zoo visitors were asked to complete a short feedback survey to evaluate their experience using a five-point rating system (5-Excellent, 4-Very Good, 3-Good, 2-Fair, 1-Poor).

Data Analysis

The average frequencies of selected behaviors from all intervals were calculated for the three study treatments. Selected behaviors included: inactivity (stationary behavior), vocalizing, walking/hopping, preening, and flying. We used a single-factor ANOVA to determine differences in the frequency of behaviors among music treatments of each bird species. Means were reported ± 1 SD. A post hoc Tukey’s HSD was used to identify the source of difference from significant ANOVA results. In all figures, means are presented $\pm$ one standard deviation.

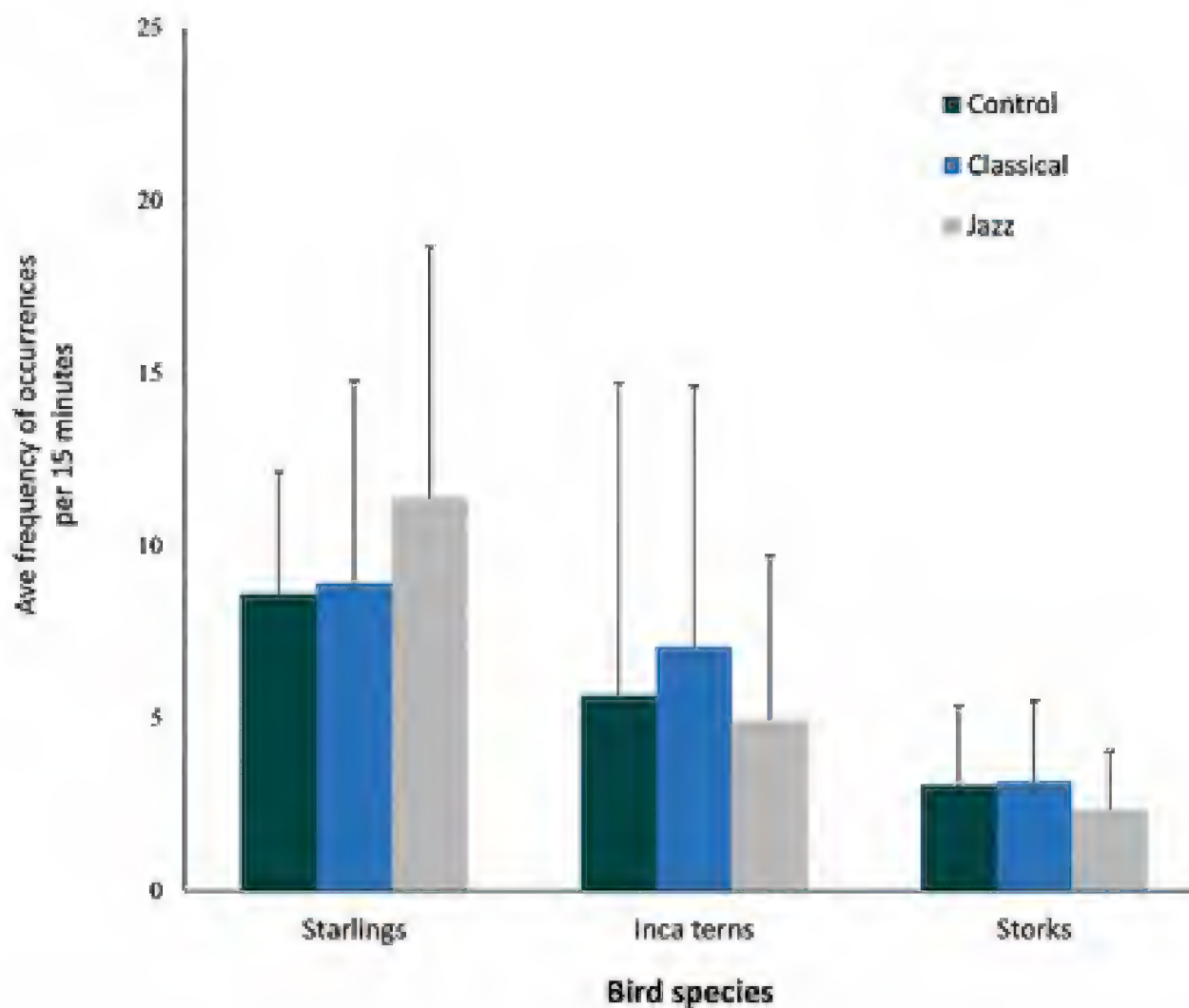


Figure 3. Average frequency of occurrences of flight behavior ($\pm 1SD$) in the three bird species during the three study treatments.

We calculated the proportions of visitors rating their experience either 4 or 5 (Very Good or Excellent) during the three study treatments and used a two-proportion Z-test to determine differences between the proportions of people who rated 4 or 5 during the control or music treatments.

Results

There was a high variability between species for each of our chosen behaviors, and each species appeared to have a unique response to the genres of music. We found a significant difference in the frequency of inactive behaviors across the three treatments

in superb starlings (ANOVA, $P < 0.05$; fig. 1). Starlings showed significantly less inactivity during jazz compared to the control or classical music (Tukey's HSD, $P < 0.05$), but did not significantly change their behavior in response to classical music compared to the control (Tukey's HSD, $P > 0.05$). The other two species showed no significant change of frequency in inactivity during any music treatment (ANOVA, $P > 0.05$).

The frequency of active behaviors (walking/hopping, vocalizing, preening, and flying) did not significantly change among the three treatments in any of the bird species over the course of the study (ANOVA, $P > 0.05$). However, we observed trends with respect to their behavioral changes. Superb starlings and white-bellied storks tended to walk or hop less when either type of music was played compared to when it was not (fig. 2). Superb starlings appeared to fly slightly more during jazz music compared to the control or classical music while white-bellied storks flew the least during jazz (fig. 3). The storks preened more frequently when classical or jazz music was played whereas the starlings preened less when classical music was played (fig. 4). There was no clear trend found for walking/hopping, flying, or preening in Inca terns (fig. 2, 3, 4). Superb starlings appeared to vocalize slightly more during the music treatments compared to the control; the other two species did not show similar trends (fig. 5). Anecdotally, we observed

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that some Inca terns and white-bellied storks approached the speaker when it had recently been turned on.

The percentages of visitors who rated their experience as a 4 (Very Good) or 5 (Excellent) in the three treatments were 86% (control, $n = 50$), 79% (classical, $n = 19$), and 95% (jazz, $n = 39$), respectively (fig. 6). Overall, jazz music had the highest rating of the three; however, there was no significant difference in the rating of visitor experience within the exhibit when classical or jazz music was played compared to the control (Two-proportion Z-test, $P > 0.05$).

Discussion

Despite evidence for some stereotypic behavior in birds, it is an issue that is infrequently studied in zoo settings. This study focused on how music could be utilized for environmental enrichment in birds. Behavioral changes appeared to be specific to bird species. We found no significant change among the three treatments in walking/hopping, vocalizing, preening, and flying. Only superb starlings showed a significant decrease in inactive behavior during jazz compared to the control or classical music. Due to our sampling methods, a high number of inactive behaviors does not imply that the birds were less active, rather that they switched behavioral states (i.e., from active to inactive) more frequently.

Previous research has shown that different bird species displayed varying responses to music (Robbins & Margulis, 2016; and examples reviewed by Wells, 2009). Robbins and Margulis (2016) found an increase of flight behavior in superb starlings, mousebirds, and Lady Ross's turacos in response to music, which is generally consistent with our observations of superb starlings. Furthermore, an increased frequency of vocalization in response to all stimuli was seen in only two of the three bird species, while Lady Ross's turacos vocalized more only when rock music was played. Similarly, we found variations in behavioral changes when comparing the three bird species in response to music genres. White-bellied

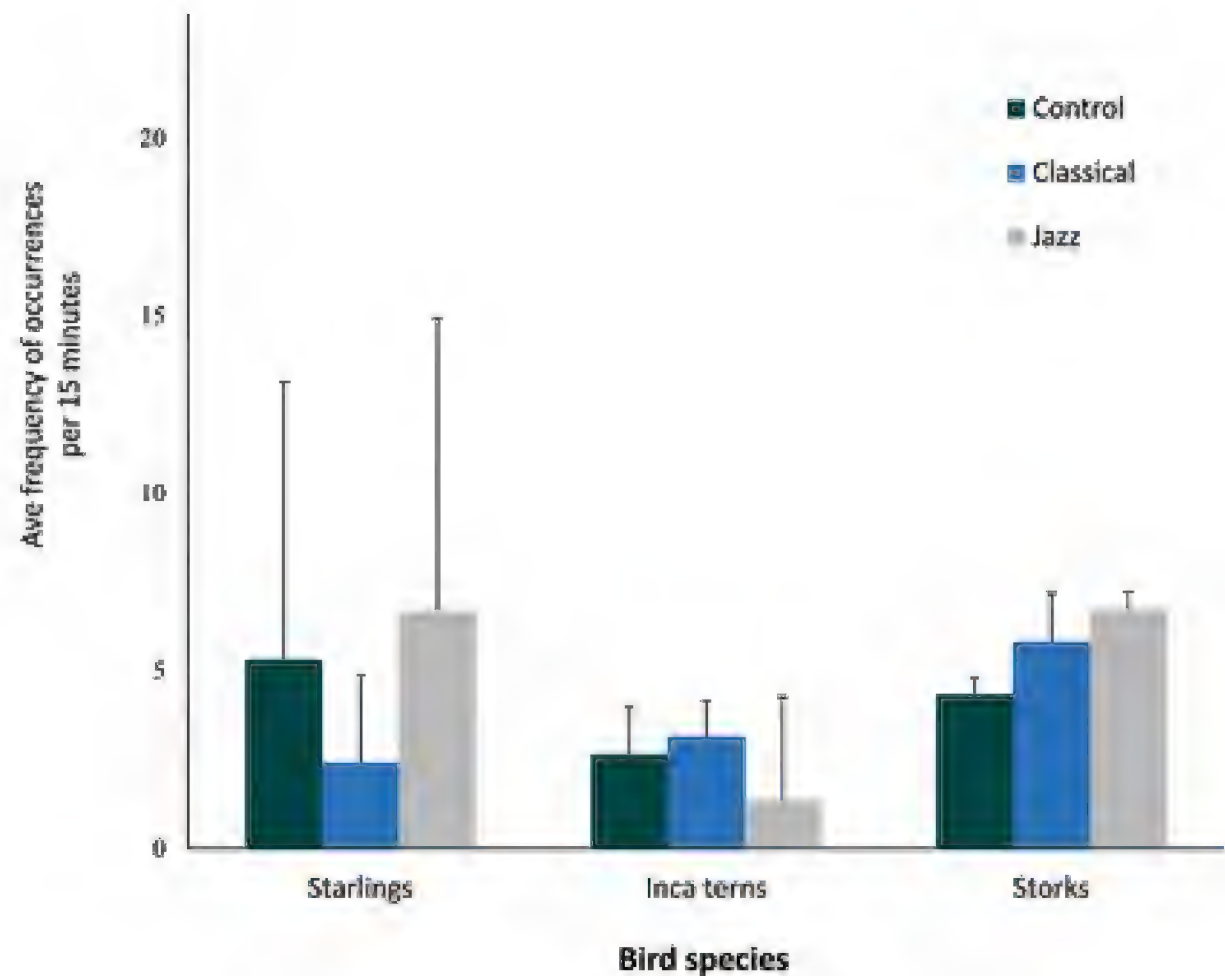


Figure 4. Average frequency of occurrences of preening ($\pm 1SD$) in the three bird species during the three study treatments.

storks tended to preen more but superb starlings preened less during classical music. Additionally, starlings appeared to fly more when jazz was played, whereas the other species showed no change in behaviors.

However, it is difficult to determine if there is a connection between these behaviors and animal welfare. Hoek and King (1997) found that through enrichment, crimson-bellied parakeets (*Pyrrhura perlata*) exhibited reduced stereotypic behavior while spending

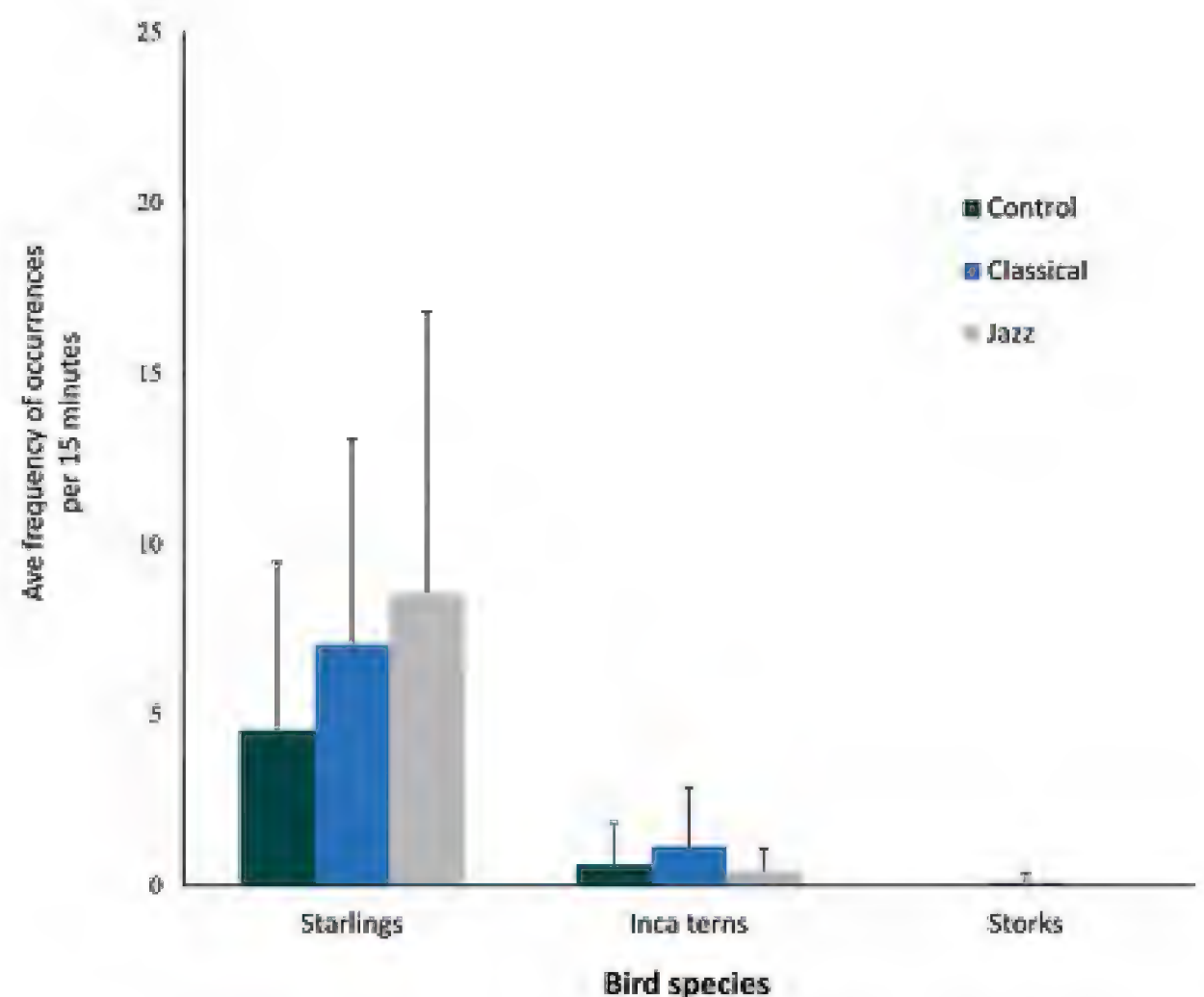
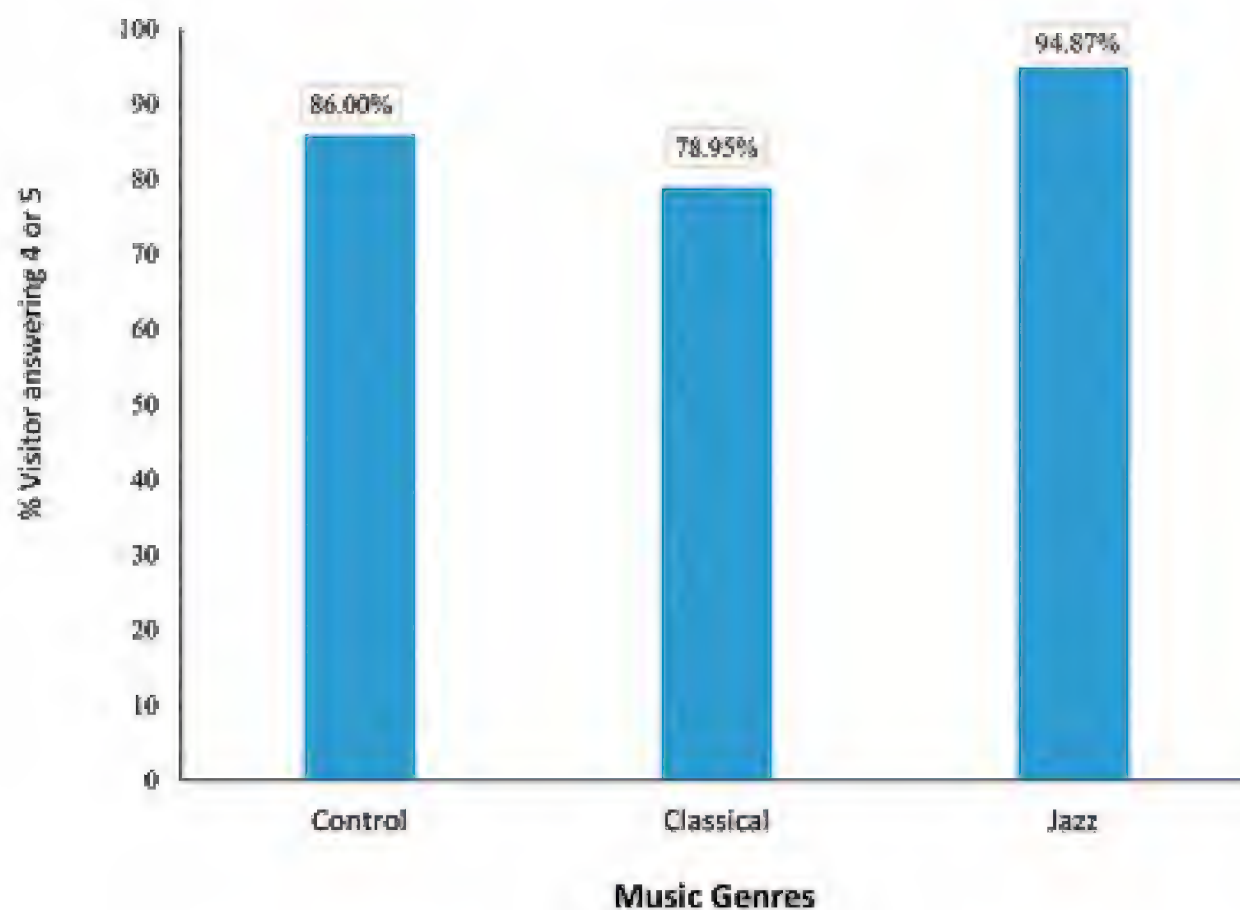


Figure 5. Average frequency of occurrences of vocalizations ($\pm 1SD$) in the three bird species during the three study treatments.



Superb Starling

more time flying, vocalizing, and preening. Likewise, we found that superb starlings appeared to display an increase in flying and vocalizing behaviors and white-bellied storks increased preening. Additional research could assess a link between an increase of these behaviors and improvement of animal health.

Because the aviary exhibit was shared by both birds and visitors, it is important to take into account how music would affect the visitors' experience before implementing auditory enrichment for birds. Previous research on the effects of auditory enrichment on birds housed within a gorilla exhibit suggested that music could enhance the enjoyment of zoo visitors (Robbins & Margulis, 2016). Our research showed that there was no significant change in visitor rating when either type of music was played. The visitors tended to like jazz music while classical lowered the visitors' rating of the exhibit.

Due to high variability across our experiment, additional research could use alternative sampling methods (e.g., scan sampling) to confirm the value of auditory enrichment in zoo aviaries. Future studies could also investigate whether the birds habituate to the music (Robbins & Margulis, 2016). Music has the potential to be utilized as an easy form of behavioral enrichment in birds.

Because species respond differently to music, the effects of music for each species need to be considered before auditory enrichment can be integrated into the exhibit.

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Don't Leave Them Ostracized: Advanced care for atypical lameness on 0.1 ostrich

Melaina Kincaid, Animal Keeper 1
Disney's Animal Kingdom
Orlando, FL



A five-year-old female common ostrich, *Struthio camelus*, at Disney's Animal Kingdom® (DAK) presented with lameness in May 2019. While standing, she would shift her weight to the left and not place her right foot fully on the ground. To address the lameness, carprofen was initially prescribed, later Gabapentin was added, and then we incorporated cold laser therapy. A lameness chart and quality of life (QOL) processes were initiated to better track her progress. A previously established solid training program was also essential in her diagnosis and treatment.

Keepers noticed several behavior changes in 0.1 ostrich "Rizzo". She was seen standing with her right foot toe-touching the ground. She was favoring the leg while walking as well as moving slower than usual. She gradually became slower to shift and began only using a small portion of the savannah, a large multi-acre multi-species exhibit. She was also not spending as much time with her two clutch mates who move through the entire savannah. Prior to her lameness, she was often observed dust bathing or using a mister, neither of which were being observed when the lameness presented.

As a result of prior tactile manipulation training, keepers were able to lift the foot to rule out a sharp object in the foot or injury to the bottom of the foot. Once this was confirmed, the veterinary staff was able to perform a voluntary physical exam which included palpation of the legs. There were no obvious signs of trauma or acute injury. Carprofen was prescribed bi-daily for seven days. Carprofen is a non-steroidal anti-inflammatory that is used as a day to day treatment for pain and inflammation in the joints. No improvement was observed on the carprofen over those seven days. Blood was then drawn voluntarily for complete blood count and chemistry panels. Again, previous training played an essential role in this as keepers were able to lift the wing for a veterinary technician to access the vein in the wing for the voluntary blood draw. The carprofen treatment was extended and increased to a higher dosage. She was prescribed stall rest for three days, and remained in the barn with 0.2 ostrich. The increased dosage and stall rest improved her lameness but the toe-touching continued.

Keepers implemented a lameness chart to more accurately monitor changes in her behavior. The lameness chart was based on the non-domestic artiodactylid chart from Fowler's Zoo and Wildlife Medicine textbook Volume 7 with ratings being 0-5, 5 being the worst (see attached chart). Rizzo's lameness score was recorded three times throughout the day, first thing in the morning, mid-day and at the end of the work day.

Once Rizzo's stall rest ended, the lameness was again present as well as the continued toe-touching and a noticeable shift in body weight when standing. It was also noticed that she was beginning to have some cracking and peeling on the toe nail. A veterinarian assessed the nail and prescribed an Artimud treatment for 14 days as well as adding Gabapentin to her medication regimen. Gabapentin is used to treat neuropathic pain. Artimud is a clay-based antimicrobial hoof putty created by Red Horse Products, www.redhorseproducts.co.uk. The Artimud was applied once a day to the nail, once it had been cleaned off. The prior husbandry training came in to play as keepers were able to easily wash off

SCORE (GRADE)	DESCRIPTION	AT REST ANALYSIS	MOVEMENT AND GAIT ANALYSIS	COMMENT
0	Sound	Even distribution of weight on all limbs	Normal gait and movement	No lameness
1	Intermittent, mildly lame	Subtle, if any, redistribution of weight at rest	Subtle occasional lameness	Mostly normal posture at rest, intermittent limp when moving
2	Mildly lame	Occasional shifting of weight or lifting of leg	Slight head nod or quick gait but moves around freely with mild lameness	Occasional change in posture; may need to exercise to see lameness
3	Moderately lame	Consistent shifting weight, obvious toe touching	Grade 2 signs, with mild reluctance to move consistent and obvious limp, short striding	Abnormal posture and gait at rest and when moving; may be trailing the herd
4	Very lame	Holds leg off ground at rest, obvious posture change	Grade 3 signs plus three-legged lameness at times, frequent stops, difficulty turning, moderately reluctant to move	Grade 3 signs plus taking deliberate steps one at a time; may be isolating from herd
5	Severely lame	Prefers to lie down	Grade 4 signs, depressed, inability or extremely reluctant to move	Severe pathology likely; behavior and well-being are affected, isolating from herd

the nail with water and a toothbrush then apply the Artimud with a clean toothbrush while Rizzo was being reinforced with soybeans by a second keeper.

A full immobilization was scheduled to further assess her condition. Veterinary staff, managers and keepers met to determine a plan for the procedure. A computerized tomography (CT) scan was the priority, followed by radiographs and an ultrasound. Rizzo had been trained for voluntary injections; however, this had not been done without food reinforcement. Keepers had to get creative on how to ensure she received the injection while still being fasted.

Her procedure took place in early July. To administer the immobilizing agents two keepers and a veterinarian entered the yard with Rizzo and a yoke, a metal pole with a padded V-shape on the end to keep the animal at a distance if necessary, set to the side for safety. One keeper held the wing to give the veterinarian access to the injection site. The keeper that would normally provide a food reinforcement had a clear cambro container with soybeans

in it with a second clear cambro on top of it to give the illusion of being able to get the soybeans for the short time it took to give the injection. Once the immobilizing agents took affect an intravenous therapy catheter was put into place to give additional drugs if required. An intubation tube was also put into place and isoflurane was given throughout the procedure. She was transported to our veterinary hospital where veterinarians palpated the legs and determined her range of motion was decreased in her right leg. Radiographs were performed as well as a CT scan on the leg. An ultrasound was preformed to rule out any reproductive abnormalities that could cause lameness. Cold laser therapy was performed on the right stifle to increase blood flow to the area and reduce inflammation. Rizzo was then transported back to the barn and reversals were administered. Her recovery was slow and she had some difficulty standing on her own so straps were used to help guide her up. She was later reintroduced to her conspecifics, 0.2 ostrich.

The radiographs and CT scan showed no significant results and were sent on to the University of Florida for a second

opinion where they reached the same conclusion. It was determined that while she is a young bird, her range of motion is decreased most likely due to arthritis. To continue to monitor her progress, a monthly QOL discussion and form were implemented. The QOL form is standard throughout DAK and is used in animals with medical conditions or geriatric animals reaching end of life. Animals are placed in categories that indicate how often animals' cases are discussed and reviewed by the entire team of keepers and managers. Category 1 is discussed quarterly, category 2 is discussed monthly, and category 3 is discussed daily. Rizzo entered the QOL monitoring at a category 2 and has since moved to a category 1. The lameness chart was also continued on a daily basis recording three times a day and eventually reduced to twice a day.

Following her procedure, it was determined that she would continue on her current dose of carprofen and she would receive an increase in her dose of Gabapentin as it seemed to have the best results thus far. We also added voluntary cold laser therapy sessions twice a week for four weeks, then once a week for two weeks. Cold laser therapy works in a way that "As cells absorb light energy from the laser, cellular metabolic rates will increase along with cellular respiratory rates. Photons penetrate to the individual cells and stimulate both the cell membrane and the structures within the cells. This causes increased production of cellular energy (ATP), which leads to normalization of cell function, pain relief and healing." (Laser Therapy in the Companion Animal Practice. Ronald J. Riegel DVM). The laser therapy required Rizzo to stand voluntarily for seven minutes, however it did not need to be continuous. Once again, the training proved beneficial. Rizzo received all of her therapy sessions for seven continuous minutes except for two of the treatments which had to be

Keepers, as well as veterinary technicians and veterinarians, have been able to provide medical care and treatments with the already established training along with some additional trained behaviors.

stopped and restarted due to outside distractions. The treatment was performed by a veterinary technician. (See photo 1). An on-contact probe was used by performing a back and forth motion over the stifle and hip areas. The probe did emit a beeping sound and was warm to the area being treated. The laser therapy also required the veterinary technician and the keepers to wear appropriate laser IV glasses. None of these conditions of the therapeutic treatment seemed to have an effect on her training behavior.

The increase in Gabapentin began several weeks prior to the laser therapy. Her gait and posture both improved on the increased amount. She began using the entire exhibit once again and was staying with the group. Her shifting response also improved at this time. No significant changes were appreciated

with the laser therapy treatments so we discontinued the therapy to determine if she showed any ill effects from not having it. She did have a small amount of increased lameness, especially on cold days so the cold laser therapy resumed to once every other week.

While the prognosis of arthritis in a young bird is not ideal, it has thus far been proven manageable. This is due in part to the husbandry training program. Keepers, as well as veterinary technicians and veterinarians, have been able to provide medical care and treatments with the already established training along with some additional trained behaviors. The husbandry training began two years prior to the medical issue and includes tactile manipulation of the entire body, lifting the wing, standing on a scale, blood draws from the wing and injections in the leg. We are currently working on A to B training to better assess the gait of the birds, voluntary radiograph training and stethoscope placement. The hope is to do voluntary annual physical examinations in the future. The lameness chart and QOL processes will continue to allow us to closely monitor her condition moving forward. 🦒





Figure 1. Marlin, adult male at the San Diego Zoo. Credit: Lynn Jackson.

The New Guinea Singing Dog

Janice Koler-Matznick

The New Guinea Singing Dog Conservation Society
Central Point, OR, USA

New Guinea, the second largest island in the world, has mountain ranges tall enough to have permanent glaciers. Many remote areas have never been fully explored. The mountains from about 2,000 m to 3,400 m are home to the wild New Guinea Dingo (NGD), also called the New Guinea Singing Dog, a named given because of its chorus howl. The NGD chorus howl is different from other canids' communal howls, because they are not merely all howling at the same time but appear to be actually coordinating their howls, counterpointing each other and creating what are known in human singing as "overtones" or "ringing chords" in which voices combine to create an added note.

In 1957, the NGD was described by E. Troughton as a new species of wild dog. He gave it the name *Canis hallstromi* after the patron of the Taronga Zoo in Australia, Sir Edward Hallstrom, who brought the first pair of NGDs out of the Papua New Guinea Highlands in 1956. Since then different authors used various names according to their personal preference. We now know the NGD is not merely a feral domestic dog, but, along with the Australian Dingo (AD), a separate evolutionary line from domestic dogs. They both qualify as true subspecies, so in all cases the *hallstromi* part of the name should be used to identify them. Some of the most used names, besides *Canis hallstromi* are; *Canis familiaris hallstromi*, and *Canis*

dingo hallstromi. *Canis lupus hallstromi* was used by several authors, however it is now known from genetics that the dog is not a direct descendant of the living gray wolf, *Canis lupus*, so that trinomial is invalid.

Dating from DNA indicates the NGD, along with the very closely related AD, became separated from the domestic dog at least 5,000 – 12,000 years ago. However, dating from DNA sequences is very questionable, and it is possible they came to New Guinea with the first people some 50,000 years ago, before dogs were domesticated. The isolated NGD could be a remnant example of early dog, perhaps a living relic from the Stone Age. The two dingo populations,

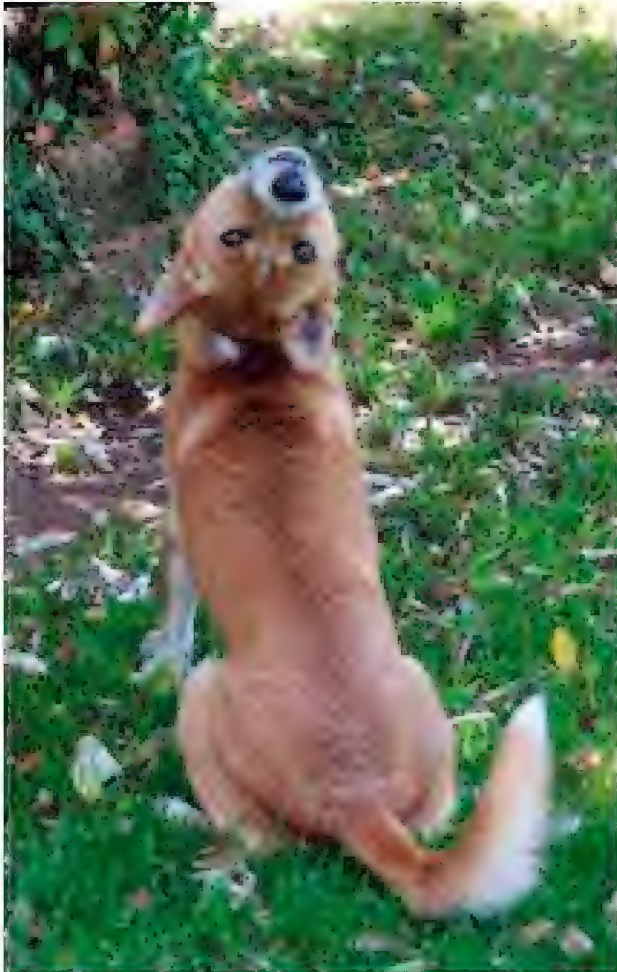


Figure 2. Young female NGD performing a "head toss." Photo by Joan Dalglish.

the only dogs today that exist as predators without any connection to humans, are rightly considered subspecies of dog, not races or breeds. The NGD could be different enough from other dogs to meet the definition of a unique species, but this can only be determined from further study of both the captive and the wild NGD's.

Almost all we know about NGD's has come from the study and observation of captives. There are perhaps 200 captive NGD's today, all descended from a few brought out of Papua New Guinea (PNG) in 1956 and from West Papua in the 1970's. From the captives we learned about the completely unique NGD breeding season and behaviors. However, it remains to be proven that the wild NGD's have the same unique characteristics.

This proof from the wild would be the first step toward NGD conservation, which could be as simple as preventing hybridization by forbidding domestic dogs into areas reserved for NGD's. In PNG the local tribal landowners would be caretakers and protect the wild NGD's, which, unlike ADs, are not in conflict with humans over livestock

or territory. Extremely little is known about the wild population, except that there are still NGD's in some remote high altitude places. Other than a few areas with reported sightings in the last decade, no one knows where they remain. New Guinea is the least explored place remaining on earth, and the least developed. It is an extremely difficult place to do field research. This is why there is no information about how many wild NGDs exist, if the population is shrinking, or how they fit into the New Guinea ecology. Locals report that they see and hear fewer NGD's compared to the "old days," that there used to be more. The domestic dog population of PNG has grown rapidly in the last few decades, and NGD habitat is being disturbed, perhaps reduced, by ever-increasing levels of exploration for natural resources, deforestation, road building, and mining. Together, more domestic dogs around NGD habitat and less habitat available result in greatly increased chances of NGD's breeding with domestic dogs. If they are going to be saved, the effort must start soon or we will have lost the last remaining

chance to study such an isolated pure ancestral-type dog.

We do know that the NGD is the top land predator of New Guinea and that their prey includes cuscus, echidnas, and birds. They use natural rock and root formations as resting dens and may be seasonally migratory within their territory. They are always reported to be extremely shy of humans and difficult to observe for more than a few seconds as they run away. The wild NGD's reported have all had red/brown or black hair, with white markings often on face, neck, chest, legs and tail tip. That is the extent of our information. Everything we learn on the first field studies, which are on-going now in Papua New Guinea by a University of Papua New Guinea PhD student Ms. Rose Singadan, and sponsored by the NGSDCS, will be invaluable. Part of her study is the collection of DNA samples from the village dogs in remote areas, to determine if they have been hybridizing with the NGD. This is entirely expected as many village hunters have over the decades brought NGD puppies back

Figure 3. Privately owned female enjoying her favorite tree. Note the gripping paws. Photo by Ray Sinclair.





Figure 4. Privately owned female enjoying her favorite tree. Photo by Ray Sinclair.

to raise in the village. Due to their aggression toward unfamiliar dogs and the rarity of domestic dogs being taken into NGD territory, it is doubtful if there has been any significant gene flow from village dogs into NGD. Ms. Singadan is also collecting stories and legends about the NGD, which are deeply ingrained in the local cultures. To many, they are regarded as spirits, or as vessels for their ancestors' spirits.

Studies of captive NGD's have shown they have many unusual and unique traits in behavior and physiology. They and the AD are the only canids in which females can have up to three repeated estrous cycles a few weeks apart during an annual breeding season. For NGD's the season starts in July. Unlike all other canids from foxes to wolves, NGD's do not have the "play bow" solicitation in which the front end is lowered and rear elevated to invite

play. One unusual behavior is the NGD "head toss" in which they bend their neck and rotate their head around, indicating they want something. They have two blood proteins that match coyote and red fox rather than domestic dog or wolf. If they have natural-type pens with suitable dirt, the females dig shallow dens for their pups, even if a nice dog house is available. Males will regurgitate food for their pups and help guard them. However, they are not social pack animals. Same-sex adults are highly aggressive toward each other in captivity, and parents begin to harass and reject same-sex offspring before the next estrous season begins. So it is assumed in the wild they live in mated pairs that defend a territory.

After diligent searching, it is believed that all of the captives alive today have descended from only five unique ancestors brought into the USA, so they

are highly inbred. While in general NGD's are still healthy and long-lived, often reaching 15 years of age, unless new genes can be brought in from the wild in the near future, the captive population will eventually die out. The Highland Wild Dog Foundation, sponsored by the Freeport Mining Company, has studied some dogs at the Grasberg Mine which is at 14,000 ft in the Papuan province of Indonesia. DNA samples they obtained were sequenced by Elaine Ostrander's Laboratory at National Institute of Health. They found that those so-called HWDs are of the same evolutionary line as the NGD, but of course had much more genetic diversity. Dr. Kylie Cairns and her group have done the most in-depth DNA studies of dingoes and discovered that the two dingoes are extremely close relatives and make up a clade of ancient dog much older than other dogs. Eventually, a few more specimens will be brought out of the wild to increase genetic diversity in the captive population. When that time comes we hope to have partnered with zoos interested in breeding who can accommodate the wild specimens for the genetic conservation plan.

NGD's are popular as educational outreach specimens in many zoos because unlike most other wild canids, when properly trained and socialized as puppies they are bold and exploratory, not fearful. With supervision they can be trustworthy ambassadors. Although the public enjoys seeing them as exhibit specimens, as evidenced from the positive comments of the San Diego Zoo visitors when the pair named Marlin and Samber illustrating this article were on exhibit for several years, their lack of official scientific status as a unique subspecies means many of the larger zoos will not dedicate space for them. Visitors nevertheless are fascinated by these dingoes, especially if there is adequate signage explaining they are living relics of the Stone Age and likely representative of the original dog before it was domesticated.

NGD's do not require any more square footage than other mid-sized canids, but they prefer to perch, to rest up off the ground. Vertical furniture such as



Figure 5. The pair, Marlin and Samber, formerly at the San Diego Zoo. Credit: Lynn Jackson.

logs, stumps, boulders, or jungle gym platforms give them the opportunity to climb and perch. They will climb trees with branches that they can reach that will hold their weight (9 -14 kg) and use them to escape over fences. They do well on a wide variety of canid diets that contain at least 25% protein, including high quality dog kibble, and they seem to prefer chicken or other fowl to beef. Although it has not been proven, some NGD's have developed heart problems that could be due to a taurine-deficient diet and so they might be cat-like in the need for this nutrient. They should be introduced to various potential foods at a young age, as they develop strong preferences early on and later changing diet takes habituation before they will accept it. Considering their highly inbred status, it is amazing that other than some cases of pancreatitis and of diabetes, most NGD's are hardy and live in good condition to at least 14 years of age. They develop very thick undercoats in cold seasons and the outer coat repels water.

It is important that the captive population is maintained, as they act as ambassadors for the conservation and study of their wild cousins. The NGSD Conservation Society, established in 1996, has kept a studbook based on known purebred zoo specimens and has planned breedings to preserve as much genetic diversity as possible. Adam Boyko, PhD, of Cornell University and Embarkvet have developed a DNA test for purebred status in NGD's. In order to preserve genetic diversity and get the rest of the population not in the studbook on a planned breeding program, the NGSDCS has opened its studbook to any non-pedigreed captive NGD's that test pure.

The New Guinea Singing Dog Conservation Society is conducting an anonymous census of the captive NGD population through Survey Monkey to get a better estimate of the number of NGDs in captivity. If you keep NGD's and would like to participate anonymously,

merely go directly to the Survey Monkey website. If you would like to share your contact information you can contact Jan Koler-Matznick at jkoler@ccountry.net. The NGSDCS website is <https://ngsdconservation.org>. 

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Training the Komodo Dragon (*Varanus komodoensis*) an A to B Behavior by Using a Visual Cue

Tracy E. Blowers and Timothy Rudy, Keepers
Disney's Animal Kingdom®
Lake Buena Vista, Florida

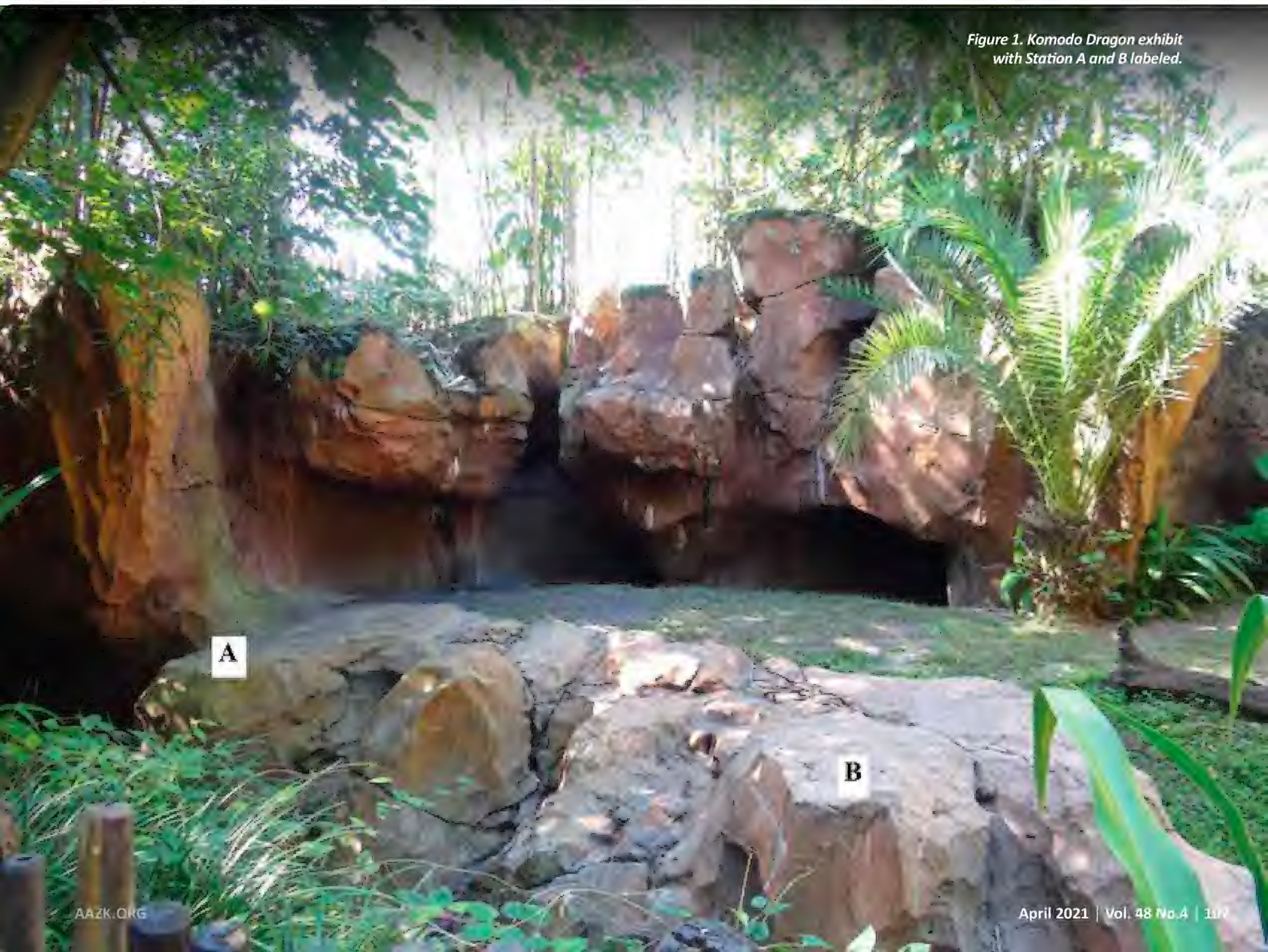


Figure 1. Komodo Dragon exhibit
with Station A and B labeled.

Introduction

The Komodo Dragons (*Varanus komodoensis*) at Disney's Animal Kingdom® are managed with the help of a protected-contact training program where they have learned behaviors such as shift, target, scale, crate, and nail trims. After these behaviors were achieved, it was decided to train a more challenging A to B behavior that required the animal to respond to a visual cue presented outside of the exhibit.

There were several reasons for developing the A to B behavior in the exhibit. 1) The keepers wanted to enhance the Komodo Dragon training program with something new to demonstrate the intellectual ability of this species. 2) The dragon sleeps a lot during the majority of the day, so this would allow the keepers to observe the animals' mobility at mid-day and increase its activity to assist with weight management. 3) It would be enriching for the animal to have an interaction randomly during the middle of the day. 4) The dragon in the exhibit would be more visible to the park guests and give us the opportunity to engage with and educate guests on Komodo Dragons and our training process. We were able to create a guest experience where a guest could be chosen as an "honorary Komodo Dragon trainer" and assist the keepers with training.

In February 2012, a male Komodo Dragon was trained to locomote between two stations in its outdoor exhibit. Stations A and B were two large flat rock areas, approximately 1.5 m in diameter, that were a natural part of the exhibit. Station A was located in the front left of the exhibit, while station B was in the front right of the exhibit approximately 5.5 m away from station A (Figure 1).

During the development of the training plan, keepers had to overcome the issues presented by training and reinforcing from a distance. The Komodo Dragon exhibit at Disney's Animal Kingdom® has a 4.5 – 6.1 meter wide moat in front

of the exhibit separating the animal from the guests and keepers' training location. Nearly all of the prior training, with the exception of shifting on and off exhibit with an audio cue, involved the dragon approaching a physical target and touching it. Keepers had to determine a method to transition from a physical cue to a remote visual cue and to reinforce the animal from a distance.

This behavior is not currently being trained on the Komodo Dragons in the current collection. Despite this, the

Methods

At the time this behavior was trained, the Komodo Dragon training team consisted of five keepers who rotated between training responsibilities for each session. The training sessions occurred 2-3 times per week on no set days and were 15-20 minutes in length. All training sessions occurred in the afternoon between 1:00 p.m. and 3:00 p.m. and began in February of 2012. The training consisted of shaping the behavior off-exhibit followed by the transition of those behaviors on-exhibit.



Figure 2. Hallway where the off-show training occurred with Station A and B labeled. .

behavior challenged both the animals and the trainers, so we felt it was a process worth sharing with the zoo community and highlighting what Komodo Dragons are capable of learning.

The A to B training began off-exhibit in the chute (Figure 2) of the Komodo Dragon holding area. The animal was cued with a maraca at the beginning of each A to B training session to let the animal know the visual cues were about to be presented. The dragon was initially targeted to move back and forth in the



Figure 3. Keeper waving flag at Station A.

chute. Keepers stationed at each end of the chute and waved a flag as a visual cue for the dragon to move toward a trainer (Figure 2). Each flag was 0.30 m X 0.25 m on the end of a 0.91 m dowel rod; one flag was yellow and one was orange. In the early training sessions the target pole was used to get the animal to come to a station. This chute set-up remained consistent throughout all stages of the off-exhibit training which was completed in 12 sessions with the animal consistently responding to the visual cue and stationing when asked.

The off-exhibit training progressed through four stages. During the first stage, one keeper, located at Station A, would give the verbal cue of “target” while presenting the target and waving the flag simultaneously. Once the dragon reached the end of the chute, he was bridged and reinforced with food. The food was tossed in rather than forceps-fed in order to prepare the animal to find the food in the exhibit

when the training moved on-exhibit. At this point, the second keeper, located at Station B, cued the animal to move to the opposite end of the chute by repeating the process. After two successful sessions, when he targeted right away, keepers felt he was ready for the next stage in the training plan.

In the second stage, the Komodo Dragon was asked to execute the A to B twice in each session. The first A to B followed the same method as in stage one. When asked for the second A to B, the target was removed. Only the flag and verbal cue “target” were given. Again, after two successful sessions, where the animal

responded to the flags and stationed right away, he was ready to move on.

During stage three (which was also successfully completed in two sessions) the target was removed completely and the waving flag and verbal cue were presented. During the final stage of off-exhibit training, the verbal cue was removed; the only cue was the waving flag. He completed the final stage after six sessions, and keepers were confident he was ready for on-exhibit training.

For on-exhibit training, keepers were located in front of the exhibit closest to stations A and B, the two large flat rock areas previously described, with the flags (Figure 3). The maraca was used again to cue the Komodo Dragon that the session was starting and he should begin looking for the visual cue.

In the beginning of the on-exhibit training, the dragon was asked to perform the A to B once. A keeper at Station A would wave the flag to cue the dragon to move in their direction. When the dragon reached the desired location on the large rock, the animal was bridged and then reinforcement was tossed into the exhibit. The second keeper at Station B then waved their flag to cue him to move to the other side. Again, when the dragon reached the desired location on the second rock, he was bridged and reinforced. After three successful sessions, keepers were confident that he could complete this behavior without hesitation.

Once the Komodo Dragon was consistently executing the A to B more than once during each session, the next

Knowing now that a behavior can be trained with a visual cue and from a distance with Komodo Dragons, this can open up other ideas in the reptile training community.

step was to get him to respond to the cue from guests, not just keepers. To accomplish this, keepers and managers (dressed in plain clothes) did the flag waving during subsequent training sessions. The dragon did not appear to be affected by who was waving the flag during these two sessions. After a total of 14 successful on-exhibit sessions, the cueing was transferred to guests.

In order to create our guest experience, keepers would ask for guest participation by having two guests stand with a keeper; one at each station. Guests were given instructions on when and how to wave the flag while keepers were responsible for bridging and tossing the reinforcement. One additional keeper would shake the maraca and interact with the viewing guests during the training session to explain to them what they were watching. Upon completion, our two volunteer guests would then be given the title of “Honorary Komodo Dragon trainer” for the day.

Conclusion

The Komodo Dragon A to B training using a visual cue, was a success, with the dragon responding much quicker than anticipated. The animal was able to accomplish all of the goals that were set for this training. He was more active and visible during the day for guests to appreciate. He participated in training sessions whenever asked. Knowing now that a behavior can be trained with a visual cue and from a distance with Komodo Dragons, this can open up other ideas in the reptile training community.

Acknowledgments

We would like to thank the following people who contributed to the success of this Komodo Dragon training plan: fellow keepers and trainers Susan Wiebe, Hilary Woodworth and Nick Milone; the Zoological Managers Jill Piltz and Scott Tidmus; the Behavioral Husbandry liaisons Lisa Davis, Angela Miller and Michelle Skurski, and Sue Maher, Rachael Daneault and Beth Richards for their editorial assistance. 🦎

Training Tale

Editor Comments by Kim Kezer

This Training Tale is an excellent example of how developing a well thought-out shaping plan aids in reaching your behavioral goals both successfully and efficiently. We have all experienced limitations with our ability to train due to various issues: staffing, time, access to animals throughout the day while they are in their habitats are a few examples. Clear, focused goals for each training session, including even the smallest details in your shaping plan, help to reach training goals in the most timely manner for everyone involved. I especially like the way this team added the step of feeding the dragon on the ground behind the scenes, rather than maintaining their use of forceps. By including this small detail it helped reduce possible frustration for the animal by creating an antecedent arrangement allowing him to locate his food quickly. It also decreased the time between behavior and reinforcement; it has been scientifically demonstrated that reducing the interval between the desired behavior and the primary reinforcer improves learning association speed.

The A to B behavior has many valuable applications, and I would recommend adding this behavior to any animal’s repertoire. Simple behaviors, like an A to B, can aid in improving our overall husbandry and management of the animals in our care. Using this behavior to observe an animal’s movement aids in making better assessments on an animal’s mobility; this is especially useful for animals with any medical or geriatric concerns. At our facility we train an A to B to move our giraffe away from us during sessions so that training props can be adjusted or changed safely without the animal present. Incorporating an A to B, like the trainers in this Tale, is a valuable way to enhance guest experience; who wouldn’t want to be a dragon trainer for a day! I know I would.

Thank you for sharing your Training Tale. As reptile training programs are not usually as common or robust as other taxa, I hope that other reptile care givers will see the value of your shaping plan and incorporate similar ideas into their behavioral programs.





Longleaf pine seedlings. Photo by The Longleaf Alliance.

Longleaf Pine Expansion on Mississippi National Forest Land – 2019 Trees for You and Me Award

*By Monica Perez-Watkins
Reforestation Partnerships Program Manager
National Forest Foundation
Missoula, Montana*

Longleaf pine forests of the southeastern United States are extraordinarily diverse and found across numerous habitats influenced by fire. Beneath the forests' fire-adapted open canopy lies one of the most plant-rich ecosystems in the temperate zone, full of species found nowhere else in the world (Peet and Allard, 1993). Longleaf pine was once the largest forest ecosystem in North America (Oswalt et al., 2012), but today exists on less than five percent of its historic range (Natural Resources Conservation Service [NRCS], 2020), about 38 percent of which lies on public lands like National Forests (Oswalt et al., 2012).

Each year, the National Forest Foundation (NFF) works to return this important native pine to its former range on National Forests in the southeastern U.S. Since 2011, we've planted nearly 3.5 million longleaf pine seedlings, helping return thousands of acres to this iconic, biologically diverse, habitat.

These efforts contribute to our broader *50 Million For Our Forests* campaign, which plants native, ecologically appropriate seedlings where they are needed most on National Forests across the U.S. As a 2019 Trees for You and Me grant recipient, we applied the NFF's \$9,562.69 award to a large longleaf pine planting project on Mississippi's De Soto National Forest. There, the seedlings will provide long-lasting benefits - habitat for wildlife, air purification, and carbon sequestration - for years to come.

Why Longleaf Pine?

The longleaf pine ecosystem once stretched across 90 million acres of the southeastern US, from Virginia to Texas (Frost, 2007). The pine's decline began when European's cleared land to transform it for agriculture (Harrington and Miller, 2013). This also led to centuries of extraction and fire suppression.

Longleaf fueled the South's construction and by 1930, most of the old-growth stands were gone. Harvested forests were later colonized and replaced by other southern pines unimpeded by longleaf's slow early growth (Oswalt et al., 2012). Longleaf pine exists in several morphological stages throughout its life, with a young "grass" stage that can last for one to six years without much above-ground growth. Logged longleaf pine stands were often replaced with loblolly pine or slash pine, favored for their earlier growth and production (Haywood et al., 2015).

Fire exclusion in forest management practices in the early 20th century further pushed longleaf out (Van Lear et al., 2005). Frequent, mild fire - both natural and human-caused - is a critical component of the ecosystem. For thousands of years, Indigenous Americans managed forests with fire to maintain the land for agriculture, habitat for game species, and for many other purposes (Zhang et al., 2010; Van Lear et al., 2005).

Longleaf pine is highly resistant to fire, though intolerant of shade and competition (USDA Forest Service),

and fire maintains the ecosystem's characteristic open canopy and botanically-rich understory of herbs and grasses. Without fire, hardwoods and fire-intolerant pines shade and close the canopy, increasing accumulated litter on the forest floor, inhibiting the growth of longleaf and its associated understory species (Harrington and Miller, 2013; Peet and Allard, 1993).

Remaining fragmented forests are small but mighty. The longleaf pine ecosystem has an understory that can hold up to 40 plant species per square yard (Harrington and Miller, 2013). This, along with the ecosystem's diverse forest structure and variability, enables it to provide a thriving home for wildlife, including more than 68 bird species and around 60 percent of the region's herpetofauna (Brockway, et al., 2005; NRCS, 2005; USDA Forest Service, 2005). Additionally, the longleaf pine ecosystem provides habitat for approximately 900 endemic species and 29 federally listed species, including the gopher tortoise (listed in its western range), red-cockaded woodpecker, and black pine snake (Addington, et al., 2014; NRCS 2020).

Longleaf seedling. Photo by US Forest Service.



Given longleaf pine's ecological significance, multiple governmental agencies, organizations, and private landowner groups are working together to return longleaf to the South. Efforts include America's Longleaf Restoration Initiative, a collaboration among partners from the public and private sector, and the U.S. Forest Service's own Million Acre Challenge. Both initiatives work to increase the acreage of longleaf pine and restore its habitat to viable, functioning ecosystems.

NFF Award: Longleaf Pine Expansion on Mississippi National Forest Land

We were delighted to receive the 2019 Trees for You and Me grant for a large 2020 longleaf pine habitat restoration project on Mississippi National Forest land. With this grant, the American Association of Zoo Keepers and Polar Bears International joined our *50 Million For Our Forests* campaign and our efforts to plant longleaf pine, and we are grateful for their support.

In Mississippi, the longleaf pine ecosystem is scattered across a quarter of a million acres, with more than half of the acreage on private lands (Mississippi State University Extension). Since 2019, the NFF has worked with The Longleaf Alliance to expand longleaf habitat on Mississippi National Forest land.

In February 2020, contractors planted 221,000 longleaf pine seedlings across 357.6 acres of three Ranger Districts of Mississippi's De Soto National Forest to restore the longleaf pine savannah ecosystem. The project was carried out by NFF partners the USDA Forest Service and The Longleaf Alliance, an NFF grantee.

The Forest Service prepared the sites for planting and provided professional tree planters and The Longleaf Alliance facilitated the purchase of containerized longleaf pine seedlings, funded by the NFF. Additional NFF funding for this project came from NFF corporate partner Patagonia Cerveza and the NFF's

general tree planting fund, which pools donations from individual donors and corporate and small business partners.

Award Impact

Planting longleaf pine will provide numerous environmental benefits, including carbon storage. Forests in the southeastern U.S. hold approximately 29 percent of the lower 48's carbon stock (Mickler et al., 2004), with the potential for even greater carbon storage through reforestation efforts such as these. Longleaf pine is thought to have long-term carbon benefits, since the species is long lived and more resistant to disturbances – including insects, disease, wildfire, and high-intensity wind – than other southern pine species (Johnson, et al., 2009; USDA Forest Service; Samuelson, et al., 2014).

As the seedlings grow, trees will store carbon in above and below ground carbon pools. One acre of longleaf pine ecosystem can store approximately 29

Seedlings. Photo by The Longleaf Alliance.



National Forest Ranger Districts	Seedlings Planted	Seedlings Planted/Acre	Total Acres Planted
De Soto	20,000	538	37.17
Bienville	181,000	622	291.00
Homochitto	20,000	680	29.41
Total	221,000		357.58

metric tons of carbon after five years, and approximately 75 metric tons after 87 years (Samuelson, et al., 2014). In total, our 357 acre project has the potential to store approximately 26,775 metric tons of carbon after 87 years – equivalent to taking more than 21,000 cars off the road for a year (US EPA).

The carbon benefits of this project will be far-reaching, extending well beyond the southern U.S. and contributing to the conservation of species most vulnerable to climate change, such as the sea ice-dependent polar bear. Closer to home, the trees will provide numerous benefits associated with tree planting, such as clean air and water and improved and expanded habitat for diverse species of wildlife. This project will also enhance the experience of forest visitors and recreationists on these public lands, providing a chance for visitors to view and kindle an interest in local wildlife.

About the National Forest Foundation

The National Forest Foundation works on behalf of the American public to inspire personal and meaningful connections to our National Forests. By directly engaging Americans and leveraging private and public funding, the NFF leads forest conservation efforts and promotes responsible recreation. Each year the NFF restores fish and wildlife habitat, facilitates common ground, plants trees in areas affected by fires, insects and disease and improves recreational opportunities. The NFF believes our National Forests

and all they offer are an American treasure and are vital to the health of our communities. Learn more at nationalforests.org. 

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